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09/677,478	10/02/2000	Guy T. Blalock	M122-1544	4522

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EXAMINER

VINH, LAN

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 09/18/2003

16

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/677,478

Applicant(s)

BLALOCK ET AL.

Examiner

Lan Vinh

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 30 June 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-3, 6, 7, 10-13, 16-19, 21-28, 30, 32, 33, 36-42, 44, 46-48, 50 and 53-79 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 21-28, 30, 32, 33, 58-61 and 69-71 is/are allowed.
- 6) ☒ Claim(s) 1-3, 6, 7, 10-13, 16-19, 36-42, 44, 46-48 and 50, 53-57, 62-68, 72-77 is/are rejected.
- 7) ☒ Claim(s) 78 and 79 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 15. 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. The request filed on 6/30/2003 for a Request for Continued Examination (RCE) under 37 CFR 1.114 based on parent Application No. 09/677478 is acceptable and a RCE has been established. An action on the RCE follows.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 67, 68 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention

Claims 67, 68 recites the limitation "the carbon component" in claim 10. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 103

- 3 The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-3, 7, 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hori et al (US 5,302,240) in view of Dahm et al (US 5,431,778)

Hori discloses a method for manufacturing a semiconductor device by dry etching.

This method comprises the steps of:

dry etching a semiconductor wafer 1 having photoresist 4 formed thereon with a fluorocarbon gas (CHF gas)/plasma etching material (col 11, lines 45-49), the gas forming a protecting film of CF on the sidewall of the film pattern on the semiconductor wafer (col 29, lines 36-38), which reads on the material forming a polymer comprising carbon and a halogen on the semiconductor wafer

after the etching step to form protecting film/polymer, etching the photoresist and protecting film/polymer film from the semiconductor wafer using CHF₃ gas/gas effective to etch polymer and photoresist from the wafer (col 31, lines 20-35, fig. 21B), after the contact hole is formed on the substrate, F (fluorine) left on the surface reacts with H (hydrogen) to form HF/hydrogen halide (col 20, lines 56-59), which reads on the gas having a hydrogen component effective to form gaseous hydrogen halide from halogen liberated from the polymer

the etching gas comprises CHF₃/hydrogen component and oxygen, the ratio of the flow rate of CHF₃ gas to the flow rate of oxygen gas is 9:1 (col 32, lines 30-31) which reads on a volumetric ratio of approximately 0.1:1 of oxygen to CHF₃/hydrogen component

Unlike the instant claimed invention as per claim 1, Hori does not specifically disclose forming the protecting film/polymer over at least some internal surfaces of a plasma chamber.

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However, Dahm, in a dry etch method, discloses etching using fluorocarbon to form polymer which coat the internal surface of the chamber (col 3, lines 21-23)

Since Hori discloses the dry etching step using fluorocarbon in an etching chamber, one skilled in the art would have found it obvious that Hori's etching step would have formed a polymer over at least some internal surface of Hori's etching chamber in view of Dahm teaching because Dahm states that carbon species within the chamber function to form a polymer which coat the reaction vessel (col 3, lines 22-23)

The limitations of claims 2-3 have been discussed above.

Regarding claim 7, Hori discloses using H_2 in the etching step (col 18, lines 56-57)

Regarding claim 62, since fig. 16 shows the etch rate of carbon film increases as the flow rate of oxygen increases, one skilled in the art would have found it obvious to adjust/increase the flow rate of oxygen by conducting routine experimentation in order to achieve increased etch rate.

5. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hori et al (US 5,302,240) in view of Dahm et al (US 5,431,778) and further in view of Barnes et al (US 5,505,816)

Hori as modified by Dahm has been described above. Hori and Dahm differ from the instant claimed invention as per claim 6 by using fluorocarbon as hydrogen component instead of ammonia.

However, Barnes, in a method of dry etching, discloses using a gas mixture comprises ammonia or fluorocarbon gas and oxygen (col 2, lines 20-22)

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Hence, one skilled in the art would have found it obvious to substitute Hori and Dahm fluorocarbon gas with ammonia gas in view of Barnes teaching because Barnes teaches that the creation of ammonia within the etch chamber provides for enhanced directional etching capabilities and results in improved anisotropic etching (col 2, lines 31-34)

6. Claims 10-13, 16-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hori et al (US 5,302,240) in view of Dahm et al (US 5,431,778)

Hori discloses a method for manufacturing a semiconductor device by dry etching. This method comprises the steps of:

dry etching a semiconductor wafer 1 having photoresist 4 formed thereon with a fluorocarbon gas (CHF gas)/plasma etching material (col 11, lines 45-49), the gas forming a protecting film of CF on the sidewall of the film pattern on the semiconductor wafer (col 29, lines 36-38), which reads on the material forming a polymer comprising carbon and a halogen on the semiconductor wafer

after the etching step to form protecting film/polymer, etching the photoresist and protecting film/polymer film from the semiconductor wafer using CHF₃/carbon compound at a pressure of 10 mTorr /subatmospheric pressure, after the contact hole is formed on the substrate, F (fluorine) left on the surface reacts with H (hydrogen) to form COF (col 20, lines 56-59), which reads on the gas comprises a carbon compound effective to getter the halogen from the etched polymer

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the etching gas comprises CHF_3 /carbon compound and oxygen, the ratio of the flow rate of CHF_3 gas to the flow rate of oxygen gas is 9:1 (col 32, lines 30-31) which reads on the carbon compound is provided at from about 5-80% by volume of the oxygen and carbon compound mixture.

Unlike the instant claimed invention as per claim 10, Hori does not specifically disclose forming the protecting film/polymer over at least some internal surfaces of a plasma chamber.

However, Dahm, in a dry etch method, discloses etching using fluorocarbon to form polymer which coat the internal surface of the chamber (col 3, lines 21-23)

Since Hori discloses the dry etching step using fluorocarbon in an etching chamber, one skilled in the art would have found it obvious that Hori's etching step would have formed a polymer over at least some internal surface of Hori's etching chamber in view of Dahm teaching because Dahm states that carbon species within the chamber function to form a polymer which coat the reaction vessel (col 3, lines 22-23)

Regarding claim 11, Hori discloses that after the contact hole is formed on the substrate, F (fluorine) left on the surface reacts with H (hydrogen) to form HF/hydrogen halide (col 20, lines 56-59)

The limitations of claims 12-13, 19 have been discussed above.

Regarding claims 16-18, Hori discloses using CO (carbon monoxide) in the etching chamber (col 32, lines 43-44)

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7. Claims 36-42, 44, 46, 72 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hori et al (US 5,302,240) in view of Dahm et al (US 5,431,778) and further in view of Hong ((US 6,103,070)

Hori discloses a method for manufacturing a semiconductor device by dry etching. This method comprises the steps of:

positioning a semiconductor wafer on a wafer receiver 22 in a plasma chamber (fig.2), the wafer having photoresist layer 4 formed thereon (fig.1A)

biasing the wafer receiver (col 34, lines 36-37)

dry etching a semiconductor wafer 1 through openings formed on the photoresist 4 with a fluorocarbon gas (CHF gas)/plasma etching material (col 11, lines 55-58), the gas forming a protecting film of CF on the sidewall of the film pattern on the semiconductor wafer (col 29, lines 36-38), which reads on the material forming a polymer comprising carbon and a halogen on the semiconductor wafer

after the etching step to form protecting film/polymer, etching the photoresist and protecting film/polymer film from the semiconductor wafer using etching gas comprises CHF_3 at a pressure of 10 mTorr /subatmospheric pressure (col 32, lines 28-33) , after the contact hole is formed on the substrate, F (fluorine) left on the surface reacts with H (hydrogen) to form COF (col 20, lines 56-59), which reads on the gas having one effective component to etch photoresist from the substrate and polymer and getter the halogen from the etched polymer to restrict further etching , the gas may include H_2 (col 13, lines 15-38)

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Unlike the instant claimed invention as per claim 36, Hori does not specifically disclose forming the protecting film/polymer over at least some internal surfaces of a plasma chamber and using negative bias to a range of 100-400 volts.

However, Dahm, in a dry etch method, discloses etching using fluorocarbon to form polymer which coat the internal surface of the chamber (col 3, lines 21-23)

Since Hori discloses the dry etching step using fluorocarbon in an etching chamber, one skilled in the art would have found it obvious that Hori's etching step would have formed a polymer over at least some internal surface of Hori's etching chamber in view of Dahm teaching because Dahm states that carbon species within the chamber function to form a polymer which coat the reaction vessel (col 3, lines 22-23)

Hong, in a plasma etching method, teaches providing negative bias voltage in a range of 100 volts to the wafer receiver (col 10, lines 32-64)

Since Hori discloses biasing the wafer receiver, one skilled in the art would have found it obvious to modify Hori and Dahm method by providing negative bias voltage to the wafer receiver as per Hong because Hong states that a pedestal bias voltage of -30 V DC is satisfactory but may range from -20 to -100 V (col 10, lines 62-64)

Regarding claims 37, 42, Hori discloses forming HF/hydrogen halide (col 20, lines 6-10)

Regarding claims 38-39, Hori discloses the etching gas comprises CHF₃/hydrogen component and oxygen, the ratio of the flow rate of CHF₃ gas to the flow rate of oxygen gas is 9:1 (col 32, lines 30-31) which reads on a volumetric ratio of approximately 0.1:1 of oxygen to CHF₃/hydrogen component

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The limitation of claim 41 has been discussed above in paragraph 4.

Regarding claim 44, Hori is silent about removing the wafer from the wafer receiver during etching, which reads on the first and second plasma etching are conducted in-situ.

Regarding claim 46, Hori discloses using CO/carbon compound (col 32, lines 43-44)

8. Claims 47-48, 50, 53-57, 75-77 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hori et al (US 5,302,240) in view of Dahm et al (US 5,431,778) and further in view of Westendorp et al (US 5,565,036)

Hori discloses a method for manufacturing a semiconductor device by dry etching. This method comprises the steps of:

positioning a semiconductor wafer on a wafer receiver 22/electrostatic chuck that is connected to a power source 24 in a inductively coupled plasma chamber (fig.2), the wafer having a photoresist layer formed on an silicon oxide layer/insulative layer , the photoresist having contact opening patterns (fig.1A)

dry etching a semiconductor wafer 1 through openings formed on the photoresist 4 to form opening within the silicon oxide/insulative layer with a fluorocarbon gas (CHF gas)/plasma etching material (col 11, lines 55-60), the gas forming a protecting film of CF on the sidewall of the film pattern on the semiconductor wafer (col 29, lines 36-38), which reads on the material forming a polymer comprising carbon and a halogen on the semiconductor wafer

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after the etching step to form protecting film/polymer, etching the photoresist and protecting film/polymer film from the semiconductor wafer using etching gas comprises CHF_3 /hydrogen component/hydrocarbon and oxygen at a pressure of 10 mTorr /subatmospheric pressure at a bias potential/ground potential (col 32, lines 28-33, col 34, lines 36-37, fig. 2), after the contact hole is formed on the substrate, F (fluorine) left on the surface reacts with H (hydrogen) to form HF (col 20, lines 56-59), which reads on the gas having one effective component to etch photoresist from the substrate and polymer and getter the halogen from the etched polymer to restrict further etching of the material on the semiconductor wafer during etching

Unlike the instant claimed inventions as per claim 47, 54, Hori does not specifically disclose forming the protecting film/polymer over at least some internal surfaces of a plasma chamber. Regarding claim 47, Hori also does not disclose using the hydrogen component comprising hydrocarbon and ammonia

However, Dahm, in a dry etch method, discloses etching using fluorocarbon to form polymer which coat the internal surface of the chamber (col 3, lines 21-23)

Since Hori discloses the dry etching step using fluorocarbon in an etching chamber, one skilled in the art would have found it obvious that Hori's etching step would have formed a polymer over at least some internal surface of Hori's etching chamber in view of Dahm teaching because Dahm states that carbon species within the chamber function to form a polymer which coat the reaction vessel (col 3, lines 22-23)

Westendorp, in a method of igniting plasma, discloses that a mixture of hydrocarbon and ammonia is used in a plasma chamber (col 2, lines 50-60)

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Hence, one skilled in the art would have found it obvious to modify Hori and Dahm by using the hydrogen component comprising hydrocarbon and ammonia as per Westendorp because according to Westendorp, preferably the mixture of the gases is ignitable by a radiofrequency source that generate 60 MHz discharge (col 4, lines 35-37)

The limitations of claims 48, 55 have been discussed above.

Regarding claim 50, Hori discloses using H_2 in the etching step (col 18, lines 56-57)

Regarding claim 56, Hori discloses that after the contact hole is formed on the substrate, F (fluorine) left on the surface reacts with H (hydrogen) to form COF (col 20, lines 56-59)

Unlike the instant claimed invention as per claims 75-77, Hori and Dahm do not disclose using the hydrogen component comprises of hydrogen and methane/
/hydrogen and nitrogen

However, Westendorp, in a method of igniting plasma, discloses that a mixture of methane, hydrogen and nitrogen is used in a plasma chamber (col 4, lines 22-33)

Hence, Hence, one skilled in the art would have found it obvious to modify Hori and Dahm by using the gas mixture as taught by Westendorp because Westendorp states that the improvements of his invention include a plurality of gases which operate in combination with one another as the ionization element (col 4, lines 20-22).

Regarding claim 77, since Hori discloses changing the process parameters such as flow rate, pressure and power to influence the etch rate (col 13, lines 16-31), one skilled

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in the art would have found it obvious to vary the flow rate of the gases by conducting routine experimentation in order to obtain desirable etch rate.

9. Claims 63-66, 73, 74 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hori et al (US 5,302,240) in view of Dahm et al (US 5,431,778) and further in view of Westendorp et al (US 5,565,036)

Hori as modified by Dahm has been described above. Unlike the instant claimed invention as per claims 63-65, 73, Hori and Dahm do not disclose using the hydrogen component comprises of hydrogen and ammonia/ammonia and methane/ hydrogen, ammonia and methane/hydrogen and nitrogen

However, Westendorp, in a method of igniting plasma, discloses that a mixture of methane, hydrogen, ammonia and nitrogen is used in a plasma chamber (col 4, lines 22-33)

Hence, Hence, one skilled in the art would have found it obvious to modify Hori and Dahm by using the gas mixture as taught by Westendorp because Westendorp states that the improvements of his invention include a plurality of gases which operate in combination with one another as the ionization element (col 4, lines 20-22).

Regarding claims 66, 74, since Hori discloses changing the process parameters such as flow rate, pressure and power to influence the etch rate (col 13, lines 16-31), one skilled in the art would have found it obvious to vary the flow rate of the gases by conducting routine experimentation in order to obtain desirable etch rate.

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Allowable Subject Matter

10. Claims 67-68 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, second paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

Claims 78, 79 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: Regarding claims 67, 68, 78, 79, no prior art of record discloses the step of plasma etching at subatmospheric pressure using a gas comprising a carbon component such as aldehyde/ ketone effective to getter the halogen from the etched polymer after the step of forming the polymer/ first plasma etching.

Claims 21-28, 30, 32, 33, 58, 69-71, 59-61 are allowed.

The following is an examiner's statement of reasons for allowance: Regarding claim 21, the cited prior art of record fails to disclose the step of after the first plasma etching and with the wafer on the wafer receiver, second plasma etching at subatmospheric pressure using a gas effective to etch polymer from the chamber internal surface and getter halogen liberated from the polymer to restrict further etching of the material on the semiconductor wafer during the second plasma etching, the gas comprising at least H₂ and NH₃. The closest prior art of Hori et al (US 5,302,240) discloses performing a second plasma using a gas comprising H₂ and CHF₃

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Regarding claim 59, the cited prior art of record fails to disclose the step of second plasma etching at subatmospheric pressure using a gas comprise oxygen, a carbon component and NH3 effective to etch photoresist from the substrate and polymer from the chamber wall. The closest cited prior art of Hori (US 5,302,240) discloses the step of second plasma etching at subatmospheric pressure using a gas comprise oxygen, CHF₃/ carbon component to etch photoresist from the substrate and polymer from the wafer.

Response to Arguments

11. Applicant's arguments with respect to claims 1-4, 6-7, 10-13, 16-19, 36-42, 44, 46, 47, 48, 50, 53, 54-57 have been considered but are moot in view of the new ground(s) of rejection.

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Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LAN VINH whose telephone number is 703 305-6302. The examiner can normally be reached on Monday-Friday 8:30 -6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 703 305-2667. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308-0661.



LV
September 12, 2003